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(54) KNITTING MACHINES

(71) We, BENTLEY ENGINEERING COMPANY LIMITED, a British company of Komet Works, New Bridge Street, Leicester, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to knitting machines and in particular circular knitting machines for producing weft knitted fabrics of intarsia design. In intarsia designs areas are knitted in solid colour by virtue of each area being knitted from yarn which is different from yarn in adjacent areas. Such fabrics may be used for making half-hose with solid diamond shaped areas, known as Argyle hose.

According to the invention, there is provided a knitting machine having a cylinder, needles and yarn feeding stations for knitting socks in intarsia design by reciprocation of the cylinder, the machine including drive means for reciprocating the cylinder in excess of 360° during an overswing period, a plurality of patterning devices for selecting needles for participating in the knitting of each portion, means operable during the overswing period for re-setting the patterning devices to vary needle selection and means for preventing raising of the needles during the overswing period. The overswing may be 45° at each end of reciprocation giving an overall swing of 450°.

Preferably the knitting machine includes a first ring surrounding the cylinder and movable in synchronization with the reciprocation of the cylinder and, cams on the ring for operating cams associated with the yarn feeding stations so as to prevent raising during the overswing period. In this way the overswing can be provided in a machine of a simple design overall. Other knitting machine operations which have to be performed at predetermined stages of reciprocation can also be simply coordinated by providing appropriate cams or other actuating

mechanisms on the first ring. Suitably the first ring rotates in synchronism with the reciprocation of the cylinder. The first ring may, for example, rotate through 360° in the time the cylinder swings eight times through 450°. Advantageously further cams are provided on the first ring for re-setting the patterning devices during the overswing period. The re-setting of the patterning devices can, for example, be conveniently effected by providing a second ring surrounding the cylinder. This second ring may be merely reciprocated at the appropriate stage and so need not be fully annular. Preferably the second ring is reciprocated by the first ring in synchronism with the reciprocation of the cylinder during the overswing.

Preferably jacks are provided for controlling activation of the needles, which jacks include a first selecting butt for co-operating with the patterning devices to select needles for participating in the knitting of each portion and a second selecting butt for co-operating with retractable cams at the yarn feeding stations to select needles operable at some stage of knitting at the respective yarn feeding stations, and the means for preventing raising of the needles during the overswing period includes a mechanism for retracting the retractable cams. Thus a plurality of patterning devices can be provided, conveniently operable in both directions of swing, having first selecting butts at the same level yet specific for each yarn feeding station. The height of the cylinder can thus be reduced. Suitably a set of retractable cams is provided for each direction of reciprocation and the sets are alternatively retractable to prevent raising of the needles during the overswing period. Advantageously the jacks having an operating butt for engaging a needle activating cam for placing a needle butt on a needle raising cam, and the first selecting butts and the patterning devices are arranged to co-operate by raising selected jacks and the second selecting butts and the retractable cams are arranged to co-operate by further raising

second selecting butts to place the operating butt on the needle activating cam.

Preferably the patterning devices include a drum, means for racking the drum, a tape for engaging the drum for perforation in accordance with patterning requirements, selector members for projection or retraction towards or away from the cylinder in accordance with perforations in the tape and a means for bluffing all selector members out of engagement with the tape before racking the drum, the patterning devices being re-settable by bluffing all selector members, racking the drum and unbluffing all selector members. Such patterning devices can be conveniently controlled in a knitting machine wherein the first ring mounts cams for bluffing and unbluffing all selector members and the second ring is reciprocable to operate a racking mechanism for the drums. The tape enables an extensive set of instructions to be included in the patterning device without using large diameter pattern drums, which might obstruct access to the cylinder.

The invention is more particularly described with reference to the drawings accompanying the Provisional Specification in which:

Figure 1 shows schematically the position of the needles by indicating the position of the needle heads in solid lines during various stages of the manufacture of a leg portion of an Argyle sock on a knitting machine according to the invention;

Figure 2 shows a plan view of a knitting machine according to the invention with parts cut-away to illustrate constructional details;

Figures 3 and 4 show details of the machine of Figure 2;

Figure 5 shows a developed inside view of a cam box lay out of the machine of Figure 2 during reciprocatory knitting of solid diamond patterned areas of a leg portion of an Argyle sock;

Figures 6 and 7 show developed views of the fabric knitted and jack butt arrangement using the machine of Figure 2;

Figures 8 to 12 show details of operation of the machine of Figure 2 using pickers; and

Figure 13 shows a perspective view of one picker on the machine of Figure 2.

Knitting solid diamond patterned areas

With reference to stage 1 of Figure 1, a cylinder 2 of a knitting machine (described in detail later) is being swung through 450° in an anti-clockwise direction with two yarn feeders 6 and 8 supplying differently coloured yarns at knitting stations A and C. Initially a station commences to actuate half the full complement of needles in the cylinder 2 so that a nearly complete course

will be formed in due course by both stations A and C jointly. Midway in this 450° swing two needles are actuated at stations B and D to take yarn from feeders 10 and 12 (Stage 2). A typical cylinder may have 84 needles so that 42 needles would be actuated at the stations A and C in the first swing although a pair of needles of each complement is actuated also at the stations B and D to provide overlap for reasons which will be discussed.

With reference to Stage 3, near the end of this first swing all needles are lowered and the yarns pass over the heads of the needles into an annular groove of a disc 14 to reduce entanglements. The disc 14 is not shown in the other Figures for clarity.

Subsequently a pair of additional needles is selected to be raised at knitting station B and another additional pair for knitting at station D for a swing of 450° in a clockwise direction. At the same time, a pair of needles is deactivated from the edges of each complement which is knitted previously at the stations A and C. The stations A, B, C and D thus knit between them a complete course from four separately supplied yarns during each swing. During further successive clockwise and anti-clockwise swings additional pairs of needles are activated for knitting at the stations B and D as other pairs are deactivated at the stations A and C until each of the four stations, knit a quarter of the full complement of needles. With the overlap each part course knitted at the stations A, B, C and D, will contain 22 stitches of a particular yarn.

With reference to Stage 4 of Figure 1, all four knitting stations are shown knitting the various yarns. At later stages, the stations A and C will knit fewer and fewer needles and the stations B and D more until the latter knits half the full complement of needles and the stations A and C two needles each. At this (always on an anti-clockwise swing) all yarn changing is done at the time the two needles are actuated at any station A and C or B and D because this is the point at which a diamond is commenced.

When the stations A and C knit subsequently, a change of yarn may be made at the feeders 6 and 8 so that on repeating the procedure, vertical rows are produced of differently coloured solid diamonds with adjacent rows overlapping. Figure 6 illustrates the pattern produced. The sock is produced by a constant total number of active needles knitting at the four stations. The yarns knitted at the individual stations form a diamond-shaped area at each station, consisting solely of that yarn.

The knitting machine construction

With reference to Figures 2 to 5, the

knitting machine has the cylinder 2. The cylinder 2 has tricks with needles 20 and jacks 22. The rim of the cylinder 2 is surrounded by the feeders 6, 8, 10, 12. Needle butts 24 are controlled by a cam box 26 surrounding the cylinder 2. The jacks 22 control needle selection and are acted on, adjacent their upper ends, by bolt cams 28 mounted in the cam box 26 surrounding the cylinder 2. Insertion of the bolt cams 28 is controlled by a rotatable ring 32 arranged concentrically with the annularly arranged cam box 26. The jacks 22 are further under the influence of four pattern units 34, 36, 38 and 40 mounted below the plate 30 and the ring 32. A reciprocable ring 42 surrounds the cylinder 2 at this low level for racking the pattern units.

The feeders 6, 8, 10, 12 are of the type which permits yarn to be trapped, cut and reinserted and which can supply different yarns to its associated knitting station A, B, C or D. The bolt cams 28 are biased to be projected in to the path of butts on the jacks by springs. Bell-crank levers 44 are pivotably mounted on the stationary plate 30. One end of each of the levers 44 serves to pull the bolt cams 28 outwards when the other end of the levers 44 acting as a cam follower engages one of the eight cams 46 on top of the rotatable ring 32 against the force of the springs. The cams 46 are arranged in two tiers one above the other and are in each tier spaced circumferentially by gaps. The ring 32 is not reciprocated and rotates through 360° in the time the cylinder 2 makes eight swings through an arc for each swing, of 45°. A spur gear 33 is drivable by actuation of a clutch 31 from the main drive of the knitting machine (see Figure 3) to rotate the ring 32 in synchronisation with the reciprocation of the cylinder 2.

The pattern units 34, 36, 38 40 (see Figure 2) include drums 48 for advancing endless tapes or bands 50 of a thick plastics sheet material. The bands have apertures in accordance with the pattern requirements. Between each drum 48 and the cylinder 2 is mounted a bank of selector levers 52 which are pivotable on an axis defined by a separately pivotable spindle 54. The selector levers 52 have on one end a pair of V-shaped inclined camming edges 56 and at the other end a nose 58 for engaging the surface of the band 50 so as to leave the edges 56 withdrawn, or for engaging in an aperture through the band 50 so as to place the edges 56 close to the cylinder 2.

Each drum 48 is racked in step with the movement of the cylinder by a racking mechanism employing a lever 60. Each lever 60 is pivotably mounted on the axis of the drum 48 and has an arm 84 to which is attached a spring 86 to urge a nose 62 of the

lever 60 into a recess 64 in the reciprocable ring 42. The lever 60 also has an adjusting screw 88 urged against an abutment 90 on a drum racking plate 92 by a spring 94. The racking plate 92 carries a pawl 96 urged into engagement with a toothed rackwheel 98 by a spring 100. The rackwheel 98 rotates with the drum 48. The ring 42 is reciprocated (see particularly Figure 4) by an arm 66 pivotably connected to it at one end and connected at the other end through appropriate levers 67 and a spindle 69 to a cam follower 68 which engages eight cams 70 on the outer periphery of the rotatable ring 32 under the tension of a spring 71. Reciprocation of the nose 62 thus causes the associated drum 48 to be racked around.

The camming edges 56 are further more periodically withdrawn, regardless of the presence of any aperture in the band 50 configuration, by a slidable arm 72 which at one end engages a nose 74 on a lever 75 pivotable conjointly with the spindle 54. The spindle 54 has keyed in it a projecting blade 76 which can push the camming edges 56 of all selector levers 52 in a bank away from the cylinder 2 and the noses 58 out of any aperture in the band against the pull of springs 80 which bias the selector levers 52 to an operative position. The lever 75 is biased to an active position up to a stop 79 by a spring 78. The other end of the arm 72 is connected to follow eight cams 82 underneath the rotatable ring 32.

The various mechanisms described co-operate during reciprocation of the cylinder 2 so as to

(a) withdraw all bolt cams 28 in the 90° transition period during the last 45° of a 45° swing and the first 45° of the next swing;

(b) project one set of bolt cams 28 during the active 360° period of a swing between the initial and final 45° and the other alternative set of bolt cams 28 during the next active swing period;

(c) rack the drums 48 once and simultaneously during the transition period; and

(d) move all selector levers 52 to an inoperative position during the transition period to disengage the levers 52 from the bands 50 while the drums 48 are racked;

The selection of the needles for intarsia diamond patterning

With reference to Figures 5 to 7, the cam box 26 includes four sectors associated with the knitting stations A, B, C, and D, each adapted to knit in both directions of reciprocation. Each sector includes a guide cam 101 located directly below the outlet of the associated feeder, and a pair of cams 102 and 104 inclined bodily, whose upper inclined surfaces serve as raising cams and whose lower inclined surfaces serve as stitch cams. The cams 102 and 104 of adjacent

cam sections are spaced and having facing ends 106. A series of guide cams 108 extend underneath the cams 102 and 104, which

5 cams 108 control unselected needle butts 24 passing below the cams 102 and 104 when the needle butts 24 have not been raised above the ends 106.

Four needle activating cams 110 are placed at a level below the cams vertically under the gap between cams 102 and 104 of adjacent knitting stations. The cams 110 having inclined faces for engaging upper jack butts 112 and causing the jacks 22 to raise selected needles to above the ends 106.

15 In one direction of reciprocation a particular cam 110 will raise jacks for needles to knit at the knitting station to one side of that cam and in the other direction of reciprocation that cam will raise jacks for needles to knit at the knitting station to the other side of that cam. Guide cams 114 are provided to control the upper jack butts 112 of non-selected needles passing underneath the cams 108. The cams 110 have transversely spaced ends 116. The bolt cams 28 are arranged as inclined plates and are arranged to project below the guide cams 114 into the path of intermediate jack butts 118 provided, depending on the complement of needles involved, at four levels *a*, *b*, *c*, and *d* on the knitting machine. The cams 28 are located vertically below the eight ends 116 of the needle activating cams 110. The cams 28 are controlled by the cams 48 on the ring 32 so that one set of bolt cams 28 is projected namely those under the end 116 which faces the advancing butts during a particular swing. One set is permitted to be projected by the gaps between the cams in a tier of the cams 48 whilst the other set is withdrawn by the cams 46 in the other tier. The butts 118 are arranged in four overlapping sectors of the cylinder 2 at levels *a*, *b*, *c*, *d* on the jacks as shown in Figure 7. The cams 28 are arranged at their different levels to selectively engage the butts 118. A series of guide cams 120 are located below the bolt cams for returning all jacks butts 22 to a low position at level K for subsequent selection by acting on a jack butt 121.

Below these guide cams 120 are located the camming edges 56 of the selector levers 52. The inclined edges are shown in Figure 5 as two separate columns for each of the pattern units 34, 36, 38 and 40. The edges 56 are arranged to engage lower jack butts 122 of which one is provided on each jack, the overall arrangement around the cylinder 2 being as indicated in Figure 7. The edges 56 engage any lower jack butts 122 at its level and raises the jack 22 concerned by the difference in height between vertically spaced camming edges 56. This raises the intermediate butts 118 at levels *a*, *b*, *c* or *d*

to the level of the cams 28 at levels *a*, *b*, *c* or *d* respectively. It should be noted that a bank of selector levers 52 is not involved in the selection of needles for the knitting station vertically above but for the knitting station to the right or left hand side thereof, depending on the direction of reciprocation as indicated by the arrows marked A, B, C, D in Figure 5.

To select a needle, two actions must be performed on its associated jack. The camming face 56 must engage its lower butt 122 and the bolt cam 28 must engage its intermediate butt 118. Failure to engage both and engagement of only one butt on the jack, either the intermediate butt or the lower butt, will leave the needle unselected.

This arrangement suppresses the unwanted selection of needles, even though the cylinder 2 has four jacks 22 (spaced 90°) with a butt 122 at a particular level and the cylinder has an active swing period of 360°. At the beginning of an active swing period, all needles are low because no needles are left up during the transition part of the swing when all selection is stopped by withdrawal of the bolt cams 28.

The manner in which this selection mechanism works is explained by referring to the group of 42 needles which knit at some stage or other at station D, but it should be understood that analogous events occur for the needles knitting at the stations A, B and C. With reference to Figures 5, 6 and 7, during previous knitting solidly knit diamonds have been produced. Of the 42 needles which have participated in making loops at station D, 21 are associated with jacks having butts 118a and 21 are associated with jacks having butts 118c. All these jacks have butts 118d. The group of 42 needles has jacks with butts 122 at 21 levels in a chevron type formation as shown in Figure 7. The station D is knitting a diamond area and has arrived at the stage where the number of needles selected to knit at the station D is gradually decreased during successive swings. 14 needles are to knit by appropriate selection at the station D during the next swing which is described in detail in the following (see Figure 6).

The next swing is to be in the direction of the arrow X in Figure 5. All needles and jacks are in a low position at the beginning of the active part of the swing. The set of bolt cams 28 appropriate to this direction of swing have been inserted and the appropriate selection of selector levers 52 have been made to give the configuration shown in solid lines in Figure 5.

The leading needle of the group of 42 which has participated with a jack which carries butts 118c and *d*. This needle is shown in Figure 5 at 160 and its jack 162 has a lower butt 122 at the lowest level of

the 21 levels in the chevron formation. The next 20 needles are also associated with jacks having butts 118c and *d* but the butts 122 occupy the upper 20 levels of the chevron formation.

After commencement of the active part of the swing, the jacks are pulled up by engagement between the butts 112 and the guide cams 114 and are then lowered by engagement between the butts at level *K* and the cams 120. The jack 162 first encounters with its butt 122 the lowermost camming face (marked as 166) of the pattern unit 40 and is raised. The bolt cam is at the level *a* in the sector of the cambox near the unit 40. As a result the jack 162 does not engage the cam 28 with any of its intermediate butts 118c or *d*. The jack is not raised onto the cam 110 and the needle 160 will not knit at the station A.

The next 14 jacks forming (group W in Figure 7 with the jack 162) will similarly be raised by the unit 40 as they successively engage the higher camming faces. Not having any butts 118a, they will not knit at the station A either.

The 12 jacks which follow (groups X and Y in Figure 7) have butts 122 placed too high to engage any of the 15 projected selector levers 52 at the unit 40 and will not knit at the station A even though the last six jacks have butts 118a at a level which would engage the bolt cam 28a if the jacks were raised by the selector levers 52. The next 15 jacks (whose leading one is indicated at 168) at group Z in Figure 7 have butts 122 at successively lower levels, sufficiently low to engage the selector levers of the pattern unit 40. As these jacks pass, the intermediate butts 118a engage the bolt cam 28a. The bolt cam 28a will lift the butts 112 on the cam 110 and the associated needles will knit at the station A, commencing with the needle indicated at 170 in Figure 5.

Whilst these events have been taking place for the trailing group Z of the group of 42 needles, the leading end of group W, beginning with the needle 160, have moved past the station D and are approaching the station C. The groups X and Y are at the station D. The following events took place as group W passed the station D.

The leading jack 162 moved toward the pattern unit 34. Its butt 122 at the lowermost level would not encounter any camming faces 56 as no selector levers 52 were projected at such a low level. The jack 162 would not cause its needle 160 to knit as a result, even though the jack 162 possesses an intermediate butt 118d which could engage the bolt cam 28d projected in that region if the jack had been raised by a selector lever 52. The next 13 jacks of group W will similarly not raise their needles to

knit at the station D. The 15th jack of group W is indicated at 172 and engages the lowermost camming face 56 indicated at 174 of the unit 34. Its intermediate butt 118d encounters the cam 28d and its associated needle 176 is first to knit at station D as a consequence.

The following jacks of group X and Y encounter the camming faces above 174 on arriving at the station D after group W has passed. As the jacks of groups X and Y all have a butt 118d, they cause their associated needles to knit at the station D.

These selections lead to the jack and needle configuration shown in Figure 5, with the needle 160 approaching the station C for knitting, the needle 176 being at clearing height to knit at the station D, and the needle 170 moving down the stitch cam at the station A.

On continuing the swing, the last jack to be raised for causing knitting at the station D, is the leading one of group Z which engages the camming face 174. This last needle is in fact the first which is knitted previously at the Station A. Similarly, the needle 176 will be selected to knit as the last needle at the station C.

As the jacks of the needles following the jack 168 associated with the needle 170 reach the pattern unit 34, their butts 122 will be low and move past the withdrawn camming faces 56 of the selector levers 52 without being raised. The associated needles of group Z will thus not knit at station D, even though the jacks have butts 118d.

Thus 14 needles will knit during this wing at station D, of which the needles at higher end will knit also at station A and C so that only 12 needles receive yarn from the feeder at D exclusively.

The selection of the needles for the four knitting stations A, B, C, D, occur simultaneously so that during the swing needles do not knit initially and then rise, more or less at the same stage (differences may occur due to different numbers of needles to knit at the various stations) to knit, and are then again kept low. Thus the knitting sequence described with reference to Figure 1 is produced.

As the swing is completed all needles have been lowered. Before the active part of the next swing commences, the sector levers 52 are reset to insert an additional pair of camming edges 56 on top of the column at the pattern unit 40 and remove one pair from below the column of the pattern unit 34. The next part course will contain two extra loops formed by the station A and two fewer for the station D because the withdrawn faces 56 at the unit 34 leave the first and the last needle to knit previously at the station in its low selected level.

It can be seen how overlap can be avoided by organising the camming face 56 so that the successive pattern units 40 and 34 do not have a pair at the same level.

Sutures between adjacent solid diamond patterned areas.

The groups of needles selected for knitting at the stations A, B, C and D may be arranged avoiding overlap so that the first needle to knit at station D, is next to the last one to knit at station C. The separate diamond areas would be held together by virtue of the continual expansion and contraction of each group. The last needle to take the yarn at station B may be (during a subsequent reciprocation) the first to take the yarn at station C, thus interconnecting the two areas. The resulting suture may leave unattractive eyelets in the fabric.

In the modified procedure described with reference to Figure 5 a single needle overlap is used. The first needle to knit at station D, will be the last to knit at station C, and during a reverse swing the first to knit at station C may be the last to knit at station D. These marginal needles will knit twice whilst all others knit once only. A small zig-zag of colours is produced at the suture. Eyelets may be avoided.

In another procedure, (see Figure 8) each knitting station is provided with a tuck cam 124 and a pair of tail-end pickers 126 for placing the last one of a group of butts of unselected needles, which pass under the cams 102, 104 onto the tuck cam 124. The needle concerned will take the yarn in its hook, without clearing the previously knitted loop. The same needle will knit at the next operative knitting station as the last of the group of needles selected to knit.

The picker 126 (see Figure 13) has a body 128 bolted next to the cylinder of the plate (not shown in Figure 2) surrounding the cam box 26. Eight pickers 126 are provided, one on each side of the four tuck cams 124. The body 128 retains a pivot shaft 130 at an inclined angle to the vertical which supports a picker arm 132. The pickers on each side of the cam 124 act in opposite senses. The picker arm 132 on one side of the shaft 130 is restrained between a pair of sprung levers 133 to bias a picker nose 134 on the other side of the shaft 130 against movement either upwards or downwards from the neutral position shown in Figure 11 and 13. The nose 134 has a notch 136 for engaging needle butts 24, a flat portion 138 (see Figure 8) next to the notch 136 to enable the nose 134 to be depressed by a train of butts 24, and a flat portion 140 below the notch 136 for lifting it.

The operation of the pickers 126 is illustrated in Figures 8 to 12. Initially (Figure 8) during a swing of the cylinder 2 the needles

are at an inactive level and a first picker nose 134 on one side of the cam 124 is kept pressed down by a succession of needle butts 24. When needles have been selected (by their associated jacks 22 riding up an activating cam 110 as described previously) the succession of butts is interrupted. The group of butts of selected needles pass over the cams 102, the group of un-selected butts underneath. As the last butt of the un-selected group passes under the cam 102, the pressure on the portion 138 is relieved, and the nose 134 rises to catch this last butt in the notch 136. This butt pushes the nose 134 forward and because of its pivotal operation in an inclined plane, also upwards to the side of the tuck cam 124 (Figures 9 and 10). As the nose 134 continues to pivot, the last butt slips off and meets the tuck cam. The needle associated with this butt rises to tuck height and is the first needle to take the yarn at that station with the following needles first having risen to clearing height. The nose 134 is biased to return to the neutral position but is kept on top of the following group of butts, either by meeting the butts with its flat portion 140 when it returns or by lifting the nose 134 when it is engaged by the leading butt which cams the nose 134 upwards.

The succession of butts existing prior to the lifting of selected needles kept the second picker nose 134 on the other side of the cam 124 in a raised position. The second nose 134 as the last butt passes under it is then depressed by the succession of butts of needles which have been lifted and are now passing down the cam 104. The second picker nose is thus activated and can operate in a manner identical to the first picker during a reverse swing when the first picker is inactive (see Figure 12).

Using this picker procedures, the suture may be made without eyelets and straight, the adjacent patterned areas being joined closely together.

A control may be provided for the pickers on the rotating ring to deactivate the pickers at the end and the beginning of a swing when they are not operational and during rotary knitting.

It should be noted that the minimum number of needles selected is two. Using the pickers an interruption of three butts is the smallest ever to occur in the succession of un-selected needle butts 24. The picker nose 134 should be of such a length that it can pass through this interruption.

Wrap effects

A wrap-head cam can be designed, which is of a simple construction for using during the knitting of solid diamond patterned areas as described. Since the needles are all lowered at the beginning and end of swing,

a wrap finger can be swung between adjacent needles to place an effect yarn in a selected needle hook and be knitted in. The wrap fingers may be returned after the needles have been lowered. The wrap finger can be programmed to wrap the yarn around a sector of needles during successive swings to give a zig-zag pattern.

10 *Alternative sock designs*

Apart from diamond-shaped patterned areas, other shapes may also be produced such as parallel vertical stripes or squares. The areas can be joined using the pickers in the manner described previously or using limit overlap between the sectors of needles involved in producing adjacent areas.

Knitting a heel or toe position

20 Socks produced by the apparatus and procedure described may have reciprocated heel and toe portions.

The knitting station A is kept active and the needles are controlled by the pattern unit under the knitting stations B and D, during alternate swings. The remaining knitting stations C and E are kept inactive and the elastic feeders are arranged with blank sectors for blank operation at knitting station B. Even though the drums 48 are being racked as during the knitting of diamond-shaped areas.

If pickers are used each course knitted during reciprocation differs by two stitches from its predecessor, because the needles are taken into and out of action by the selector levers 52 acting on the lever jack butts 122. The production of heel of an unobtainable shape can be avoided by narrowing and widening once every two courses. Alternatively the heel is produced by first decreasing the number of active needles, secondly, after some part courses, increasing their number, thirdly decreasing them again and then increasing until the heel pouch is finished. A Y-shaped suture is produced on each side of the sock.

When pickers are used as described previously to raise the trailing end needle at station A to tuck height, after a pair of needles have been activated or deactivated by the pattern units B or D, the actual increase or decrease per part course is one stitch. The heel pouch can therefore be produced by a simple decreasing and increasing of the number of active needles. The suture has a satisfactory appearance.

Knitting a welt portion

60 A welt may be knitted before commencement of reciprocation. When knitting the welt, the mechanism for increasing and decreasing the number of selected needles is out of action. During this rotary knitting, the ring 32 is stationary and the pattern

units are not racked. All cams 28 are withdrawn as are all selector levers 52. This may be done by de-clutching the ring 32 to stop it in this position.

Before commencing a welt, the knitting station D knits a few courses with an alginate separating yarn using a bolt cam 142 to raise all needles into action. After this the cam 142 is withdrawn (thus leaving the needles in the low inactive position) and the yarn feeder goes out of action. The cam 142 is also withdrawn during the knitting of solid diamond patterned areas.

The welt is then commenced by feeding an elastic yarn only which is supplied to the needles raised at the knitting station B after selection by blade cams 144. The blade cams 144 act on some further jack butts 146 located between the intermediate and lower jack butts. For one half of the cylinder 2, alternate jack heads carry butts 146 at level *f* and for the other half butts 146 at level *g*. All jacks alternating with the aforesaid jacks in both halves have butts 146 at level *h*. One cam 144 at the level of *f* goes in when no butts 146 are present at that level but when these arrive, the jacks 22 are raised and the butts 146 at the level *h* engage the cam 144 at that level. Then the cam 144 at level *g* goes in ready to raise jacks with butts 146 at that level, which jacks will then also engage with the cam 144 at level *h*. The jacks 22 then engage the activating cam 110 to raise their associated needles up the cam 104 at station B. A top part 148 of this cam 104 is a bolt cam, and is withdrawn for knitting the welt so that alternate needles will arrive at the feeder at tuck height thus merely taking the elastic in their hooks. About 3 or 4 revolutions are so made in this way and then the knitting station C comes fully into action as a bolt cam 150 is inserted. All needles knit at station C thus locking elastic into the fabric. The whole of the top is made in this manner, thus providing tucking at every other needle and knitting with all needle at feed C giving a 1×1 mock rib fabric structure.

Finally the cam 144 at level *f* is withdrawn while no butts are engaged with it and then the cam 144 at level *g* so that the jacks 22 are no longer raised for the station B. At this point the cam 144 at level *h* comes out and the elastic yarn is withdrawn. The bolt cam 148 is inserted ready for when reciprocation commences to knit the leg portion. The cam 150 is withdrawn stopping knitting at station C. The appropriate feeders are activated so that when reciprocation starts for the diamond patterned leg portion yarns can be taken as required.

Knitting a foot portion

Ordinary circular knitting for a foot portion can be performed by inserting the bolt cams 142 and 150. If required these cams can be withdrawn and a selection made by operating a pattern unit.

Advantages

The invention enables four feeds to be used and needles to be selected by a relatively simple mechanism without risking an unnecessary raising of needles as the cylinder swings through 450°. The use of the rotatable ring 32 enables the various operations for needle selection to be coordinated in a direct yet simple manner. The machine is compact as it has all pattern units at one level. The lower and intermediate jack butts cooperate to provide individual needle selection using a relatively short jack.

WHAT WE CLAIM IS:—

1. A knitting machine having a cylinder, needles and yarn feeding stations for knitting socks in intarsia design by reciprocation of the cylinder, the machine including drive means for reciprocating the cylinder in excess of 360° during an overswing period, a plurality of patterning devices for selecting needles for participating in the knitting of each portion, means operable during the overswing period for re-setting the patterning devices to vary needle selection and means for preventing raising of the needles during the overswing period.

2. A knitting machine according to claim 1 in which the knitting machine includes a first ring surrounding the cylinder and movable in synchronization with the reciprocation of the cylinder, and cams on the ring for operating cams associated with the yarn feeding stations so as to prevent raising during the overswing period.

3. A knitting machine according to claim 2 in which the first ring rotates in synchronism with the reciprocation of the cylinder.

4. A knitting machine according to claim 2 or claim 3 in which further cams are provided on the first ring for re-setting the patterning devices during the overswing period.

5. A knitting machine according to any of the preceding claims in which the knitting machine includes a second ring surrounding the cylinder for re-setting the patterning devices simultaneously during the overswing period.

6. A knitting machine according to any of claims 2 to 5 in which the second ring is reciprocated by the first ring in synchronism with the reciprocation of the cylinder during the overswing.

7. A knitting machine according to any of the preceding claims in which jacks are provided for controlling activation of the needles, which jacks include a first selecting butt for co-operating with the patterning devices to select needles for participating in the knitting of each portion and a second selecting butt for co-operating with retractable cams at the yarn feeding stations to select needles operable at some stage of knitting at the respective yarn feeding stations, and the means for preventing raising of the needles during the overswing period includes a mechanism for retracting the retractable cams.

8. A knitting machine according to claim 7 in which a set of retractable cams is provided for each direction of reciprocation and the sets are alternatively retractable to prevent raising of the needles during the overswing period.

9. A knitting machine according to claim 7 or claim 8 in which the jacks have an operating butt for engaging a needle activating cam for placing a needle butt on a needle raising cam, and the first selecting butts and the patterning devices are arranged to co-operate by raising selected jacks and the second selecting butts and the retractable cams are arranged to co-operate by further raising second selecting butts to place the operating butt on the needle activating cam.

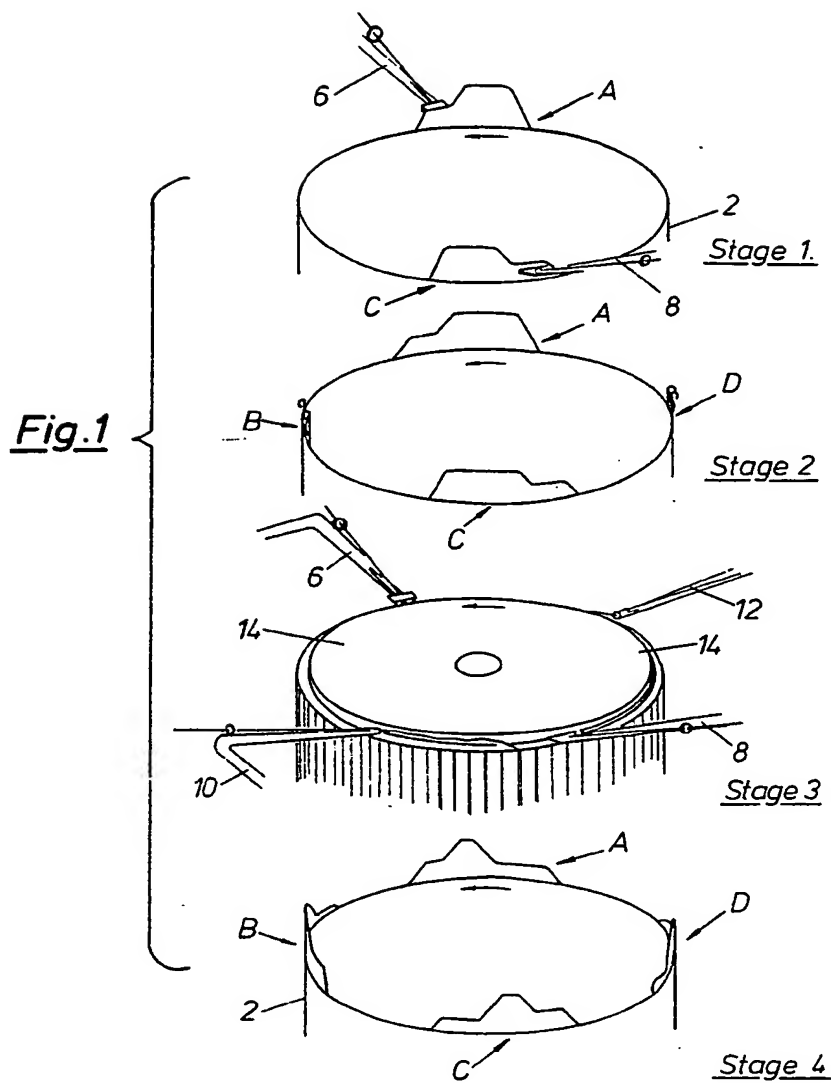
10. A knitting machine according to any of the preceding claims in which the patterning devices include a drum, means for racking the drum, a tape for engaging the drum for being perforated in accordance with patterning requirements, selector members for being projected or retracted towards or away from the cylinder in accordance with perforations in the tape and a means for bluffing all selector members out of engagement with the tape before racking the drum, the patterning devices being resettable by bluffing all selector members, racking the drum and unbluffing all selector members.

11. A knitting machine according to claims 2, 4, 5, 6 and 10 in which the first ring mounts cams for bluffing and unbluffing all selector members and the second ring is reciprocable to operate a racking mechanism for the drums.

12. A knitting machine substantially as described herein with reference to the drawings accompanying the Provisional Specification.

SERGEANTS,

Chartered Patent Agents,
25 The Crescent,
Leicester.



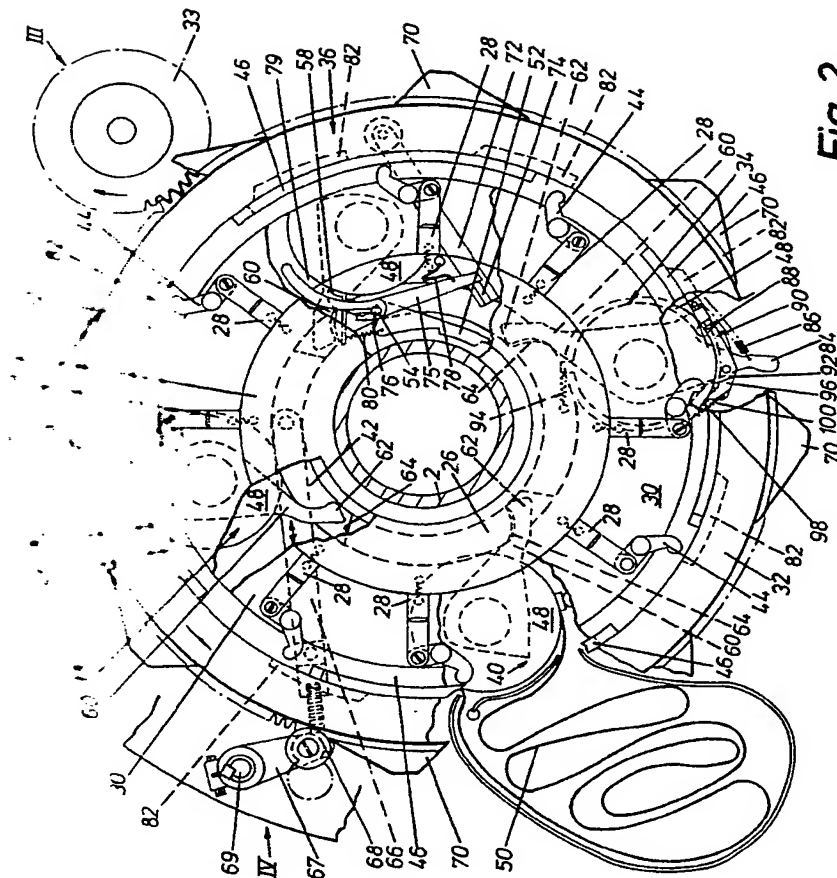


Fig. 2

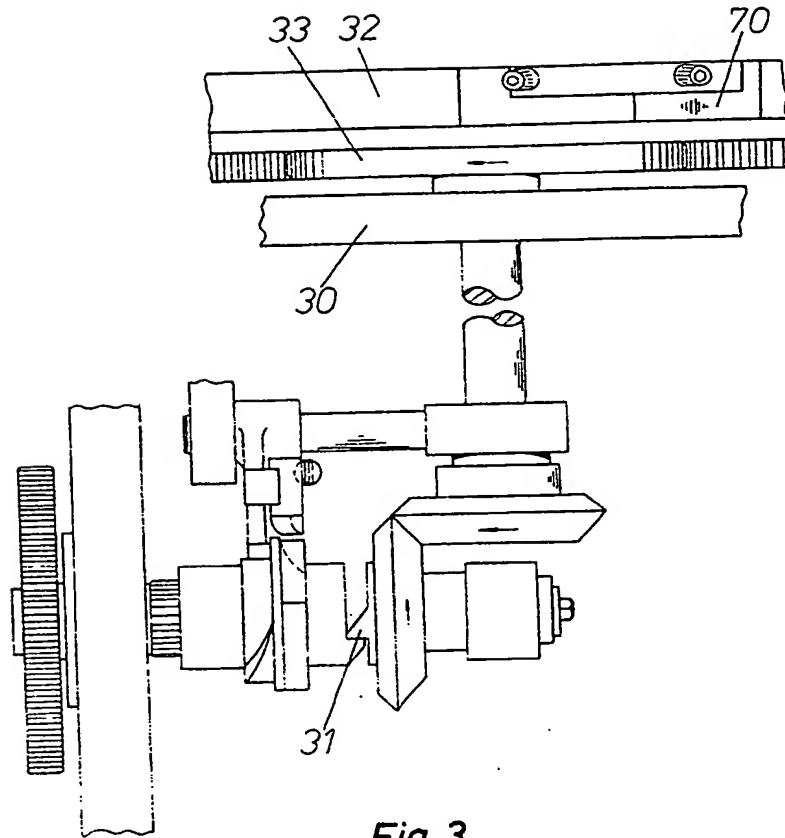


Fig. 3

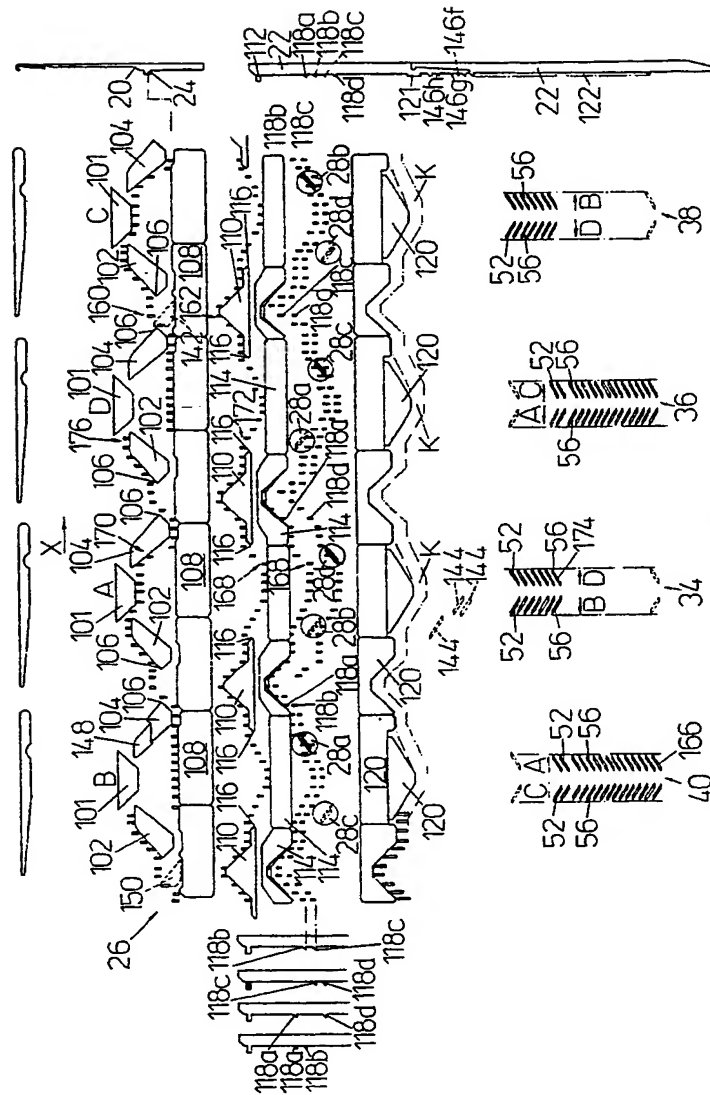


Fig. 5

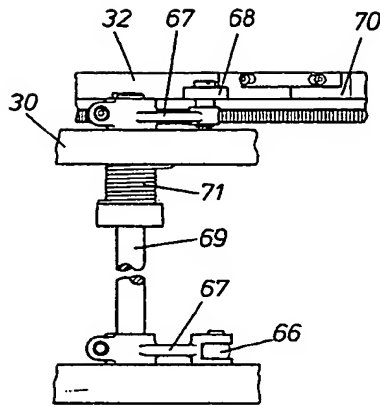


Fig. 4

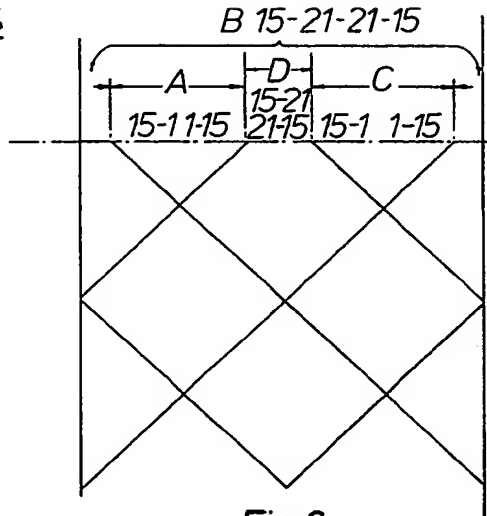


Fig. 6

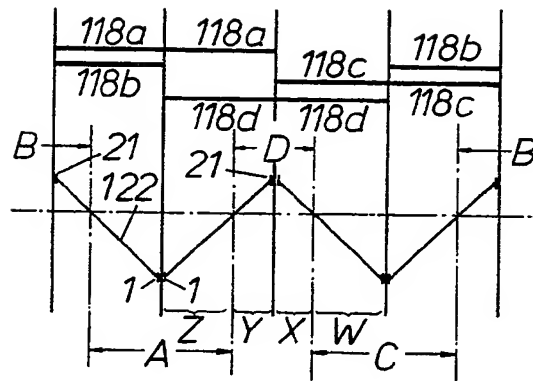


Fig. 7

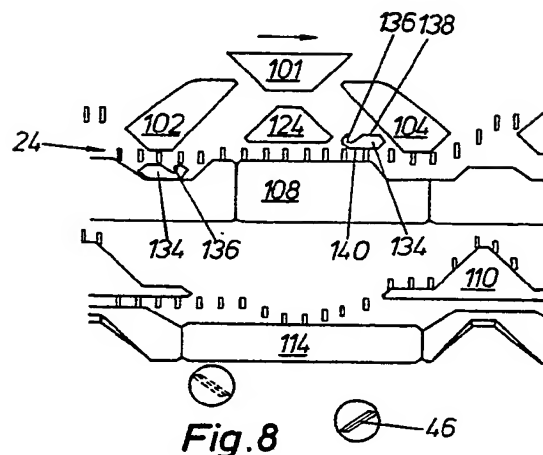


Fig. 8

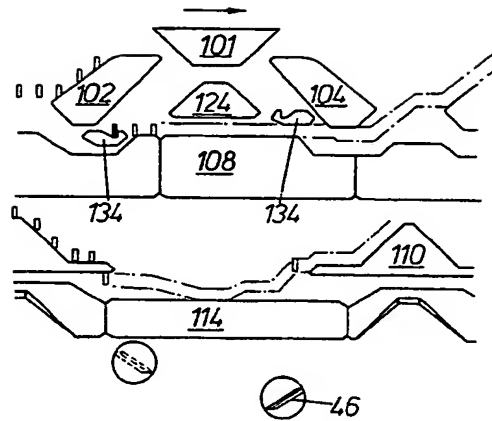


Fig. 9

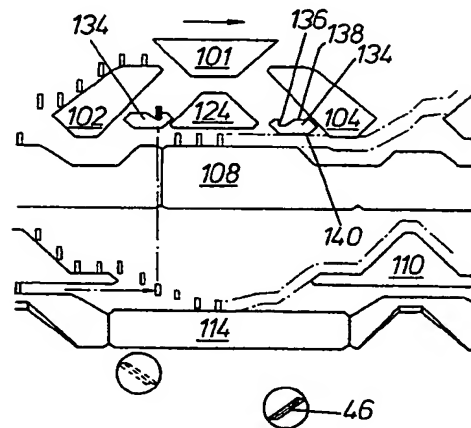


Fig. 10

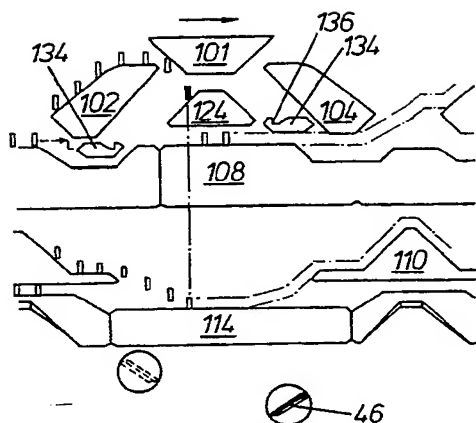


Fig. 11

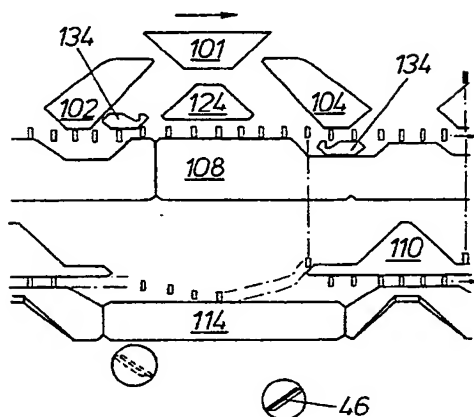


Fig. 12

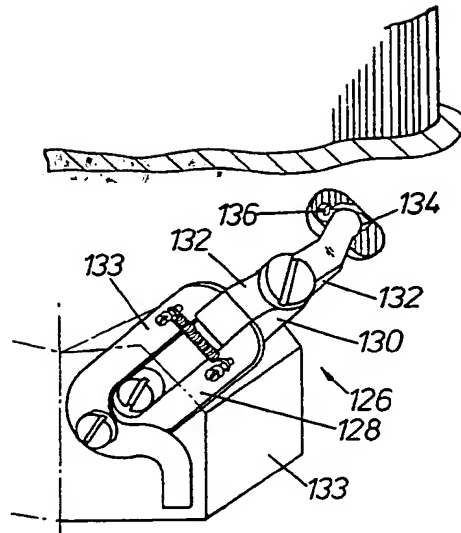


Fig. 13

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